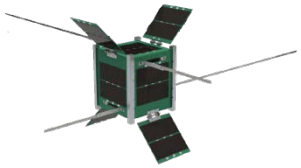
CubeSat Launch Initiative

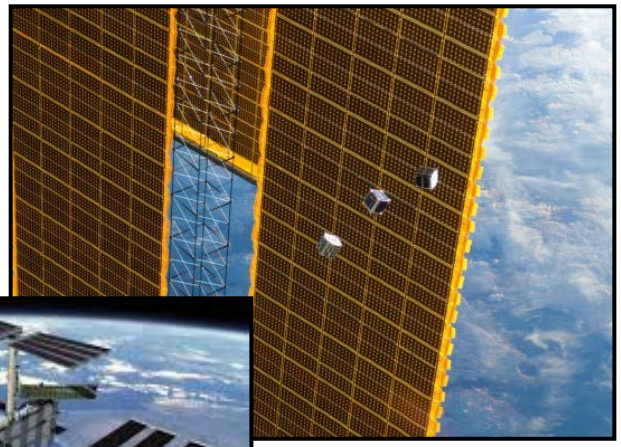


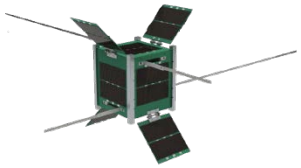
CubeSat Launch Initiative

NASA's CubeSat Launch Initiative (CSLI) provides opportunities to educational and non-profit organizations to build small satellite payloads which will fly as auxiliary payloads on previously planned missions.

NASA
DoD
NRO

ISS





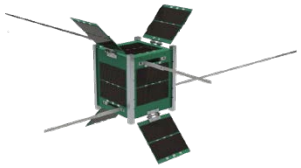
CubeSat Launch Initiative

Objective

- Provide CubeSat Launch Services on Expendable Launch Vehicles and the International Space Station to U.S. Educational Institutions, Non-profits and NASA Centers.

Aligned to NASA's Strategic Plan

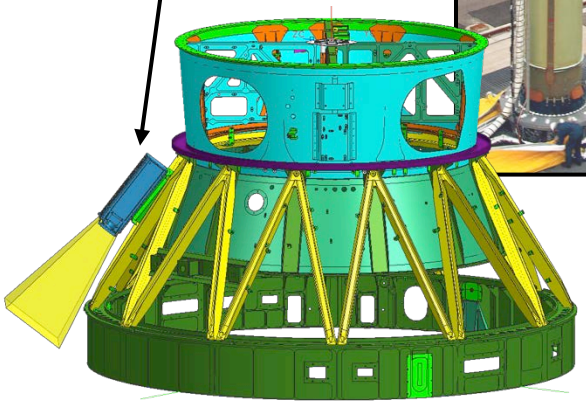
- Strategic Goal 2: Expand scientific understanding of the Earth and the universe in which we live.
- Strategic Goal 3: Create the innovative new space technologies for our exploration, science, and economic future.
  - 3.1 Sponsor early-stage innovation in space technologies in order to improve the future capabilities of NASA, other government agencies, and the aerospace industry.
  - 3.2 Infuse game-changing and crosscutting technologies throughout the Nation's space enterprise to transform the Nation's space mission capabilities.
  - 3.3 Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.
- Strategic Goal 6: Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy.

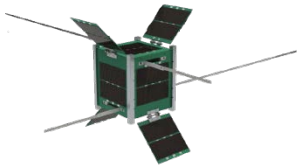


What is a CubeSat?

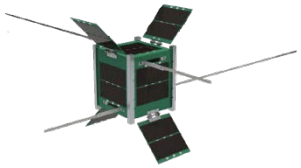
- A CubeSat is a type of space research nanosatellite
- The base CubeSat dimensions are 10x10x11 centimeters (one "Cube" or "1U"), or approximately four inches
- CubeSats are typically 1U, 2U, 3U, or 6U in volume and typically weigh no more than 1.33 kilogram (about 3 pounds) per 1U Cube
- CubeSats are typically low-cost, high risk-tolerant payloads
- Deployed from standard deployers, such as the “Poly-Picosatellite Orbital Deployer (P-POD)”
- P-POD’s versatile, small profile, tubular design holds three 1U CubeSats or can integrate CubeSats of different lengths (i.e., up to 3U)

P-POD





ISS Deployment



How It Works?

NASA Announcement of Opportunity

- NASA solicits proposals through an Announcement of Opportunity (AO)
- Educational Organizations, Non-Profits and NASA Centers submit proposed CubeSat Missions in response to AO

NASA Review

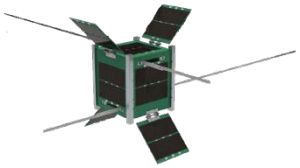
- A NASA Selection Committee made up of members of HEOMD (including the Launch Services Program), Space Technology Mission Directorate, Science Mission Directorate, and Education reviews proposals
- Selection Committee makes final recommendations on CubeSats
- NASA announces selection recommendations

Selectees Develop/Design/Build CubeSat

- Selectee builds satellite
- Selectee raises all funds necessary for satellite construction
- Selectee provides NASA completed satellite for integration for launch

NASA Assigns CubeSats to Manifested Launches

- NASA manifests CubeSat on available flights using excess lift capacity
- Cooperative Research and Development Agreement executed by NASA

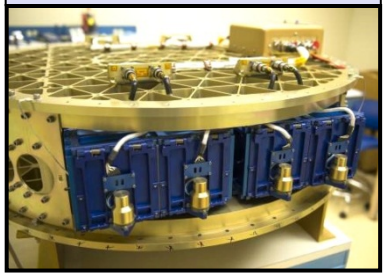


How It Works?

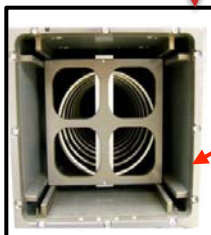
CubeSats are Developed/ Designed/Built (Students)

CubeSats are placed in P-POD

P-POD is integrated on the Launch Vehicle (LV)

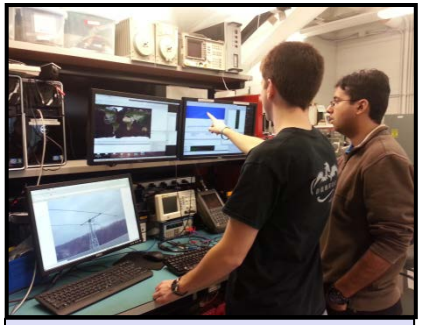


Mission Launches



Deployment spring and pusher plate

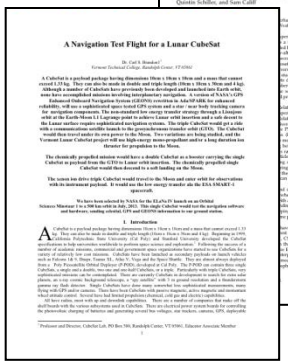
Signal Sent to LV, spring-loaded door is open, CubeSats deployed



Students or Center track and operate CubeSat from Ground Station

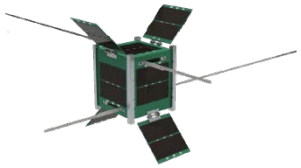
CubeSat burns up on re-entry after completion of mission

Small Mission Accomplished by Students—Big Impact on Space Weather Research



A Navigation Test Flight for a Lunar CubeSat

Students or Center analyze data, write technical papers, provide results and data to NASA



CSLI Benefits

Benefit to Educational Organizations and Non-profits:

- Enables students, teachers and faculty to obtain hands-on flight hardware development experience
- Advances the development of technologies
- Provides mechanism to conduct scientific research in the space environment
- Provides meaningful aerospace and Science, Technology, Engineering and Mathematics (STEM) educational experience

Benefit to NASA:

- Promotes and develops innovative public-private partnerships
- Provides a mechanism for low-cost technology development and scientific research
- Enables the acceleration of flight-qualified technology assisting NASA in raising the Technology Readiness Levels (TRLs)
- Strengthens NASA and the Nation's future STEM workforce

2009–2014 CubeSat

114 Organizations – 29 States & DC

ELaNa IV

(Educational Launch of Nanosatellites)

November 19, 2013

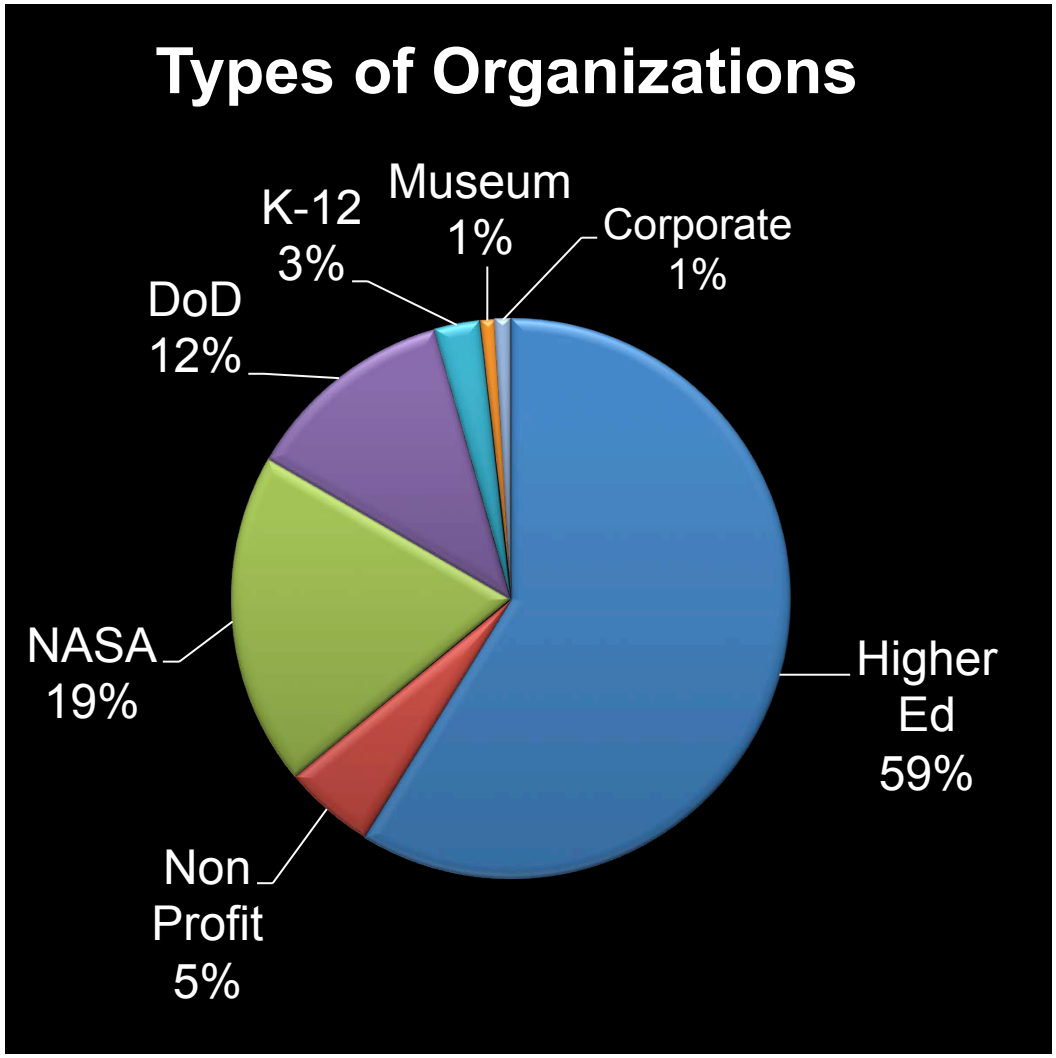
ELaNa II

December 5, 2013

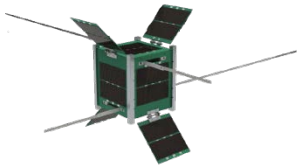
ELaNa V – SpX-3

March 16, 2014

Types of Organizations



- Eligible Organizations include: Educational and Non-profit Institutions, NASA Centers
- Majority of proposing organizations are universities
- 48% of the universities utilize Space Grant and Experimental Program to Stimulate Competitive Research (EPSCoR) Funding
- 2013 we launched TJ^{3}Sat, the first CubeSat built by and launched for a high school
- Elementary and middle schools' proposals have been submitted



CubeSat Focus Areas

Proposed CubeSats must align to NASA's Strategic Plan and, if appropriate, the Education Strategic Coordination Framework.

- 70% conducting Technology Demonstrations
- 50% conducting Scientific Research
- 50% supporting Education

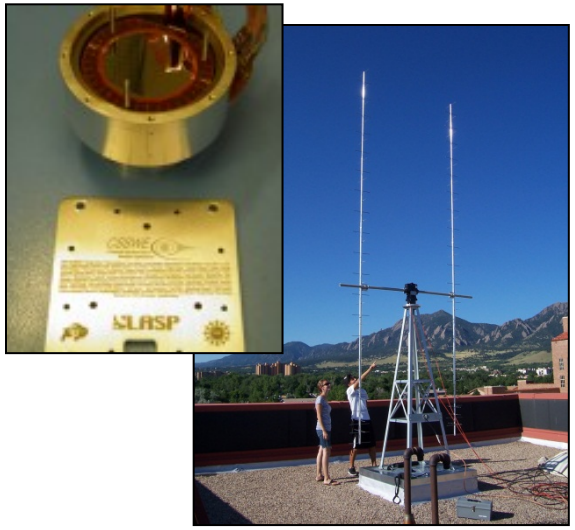
Scientific Research

- Biological Science
- Earth Science
  - » Snow/Ice Coverage
- Near Earth Objects
- Orbital Debris Tracking
- Space Based Astronomy
- Space Weather

Technology Demonstrations

- In-Space Propulsion
- Space Power
- Radiation Testing
- Tether Deployment
- Solar sails
- Material Degradation
- Solar Cells
- Additive Manufacturing

Missions Examples



CSSWE
University of Colorado – Boulder, Co.

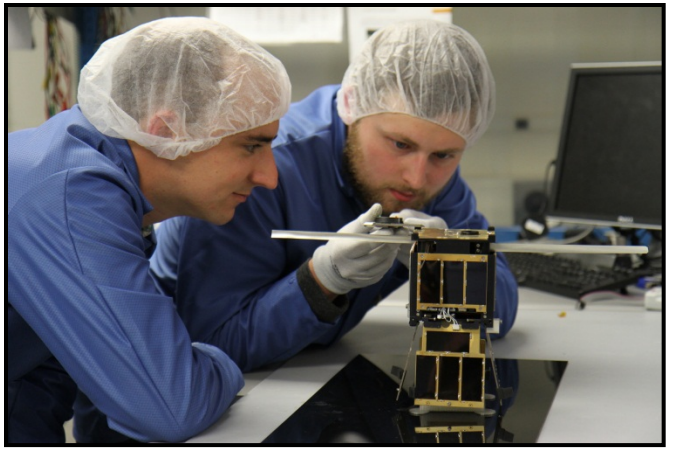
- Measure the directional flux of Solar Energetic Protons (SEPs) and Earth's radiation belt electrons in support of NASA's Radiation Belt Storm Probe Mission
- Space Weather - Heliophysics
- Payload: Relativistic Electrons and Proton Telescope

GOAL: Understand the relationship between SEPs flares and coronal mass ejections

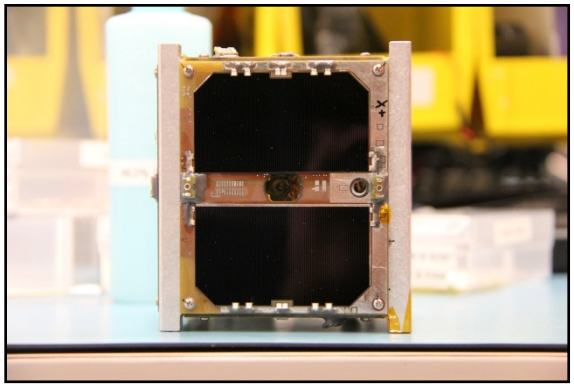
KySat-2
University of Kentucky – Lexington, Ky.
Morehead State University – Morehead, Ky.

- Test components of a novel attitude determination system called a Stellar Gyroscope that uses sequences of digital pictures

GOAL: Determine the three-axis rotation rate of the satellite



Missions Examples



M-Cubed
University of Michigan – Ann Arbor, MI.

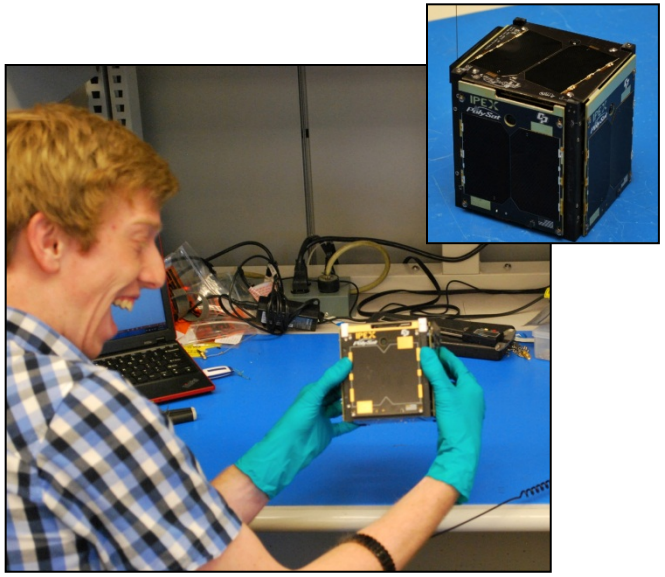
- Obtain mid-resolution imagery of the Earth's surface and carry the JPL/Caltech CubeSat On-board processing Validation Experiment (COVE)

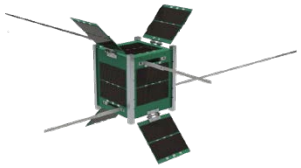
GOAL: COVE will advance technology required for real-time, high data-rate instrument process for future Earth Science

IPEX
JPL/Cal Poly – Pasadena, Calif

- Demonstrate Intelligent Payload Module (IPM) technologies including autonomous onboard instrument processing, downlink operations, and automated ground operations

GOAL: Validate IPM technologies which is a baseline for the HyspIRI Decadal Survey Mission





Feedback

"The ELaNa program has been a game changing event for our research center. It has allowed us to be able to show past performance in the areas of nanosatellite development. This achievement has easily resulted in over $1M in future research projects for the University of New Mexico."

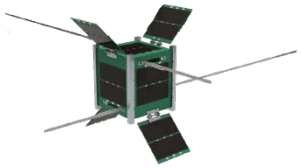
Craig Kief – TrailBlazer
Deputy Director
Configurable Space Microsystems Innovations & Applications Center (COSMIAC)

"Universal, location-independent service is a distinguishing feature of satellite technology. In that spirit, this NASA launch has afforded for our students, here in Louisiana, the same access to this high-technology areas as anyone else anywhere in the nation, and indeed around the world."

George Thomas – CAPE-2
Professor of Electrical and Computer Engineering
University of Louisiana, Lafayette

"The NASA ELaNa program provides an educational experience for the student team that can not otherwise be duplicated in a University setting. Students go from concepts on paper to operating their hardware on-orbit and the lessons learned between those two points is invaluable."

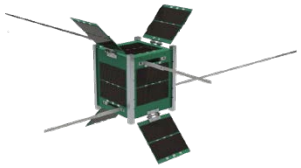
Professor James Lumpp – KYSat-2
Electrical and Computer Engineering, University of Kentucky



Mission Schedule

CubeSat Mission	Primary Mission	Launch Date	PPODs	CubeSats
ELaNa-I	Glory	Mar 4, 2011	1	3
ELaNa-II	NROL-39*	Dec 5, 2013	2	4
ELaNa-III	NPP	Oct 28, 2011	3	5
ELaNa-IV	ORS-3*	Nov 19, 2013	4	11
ELaNa-V	CRS SpX-3	Mar 16, 2014	4	5
ELaNa-VI	NROL-36*	Sep 13, 2012	3	4
ELaNa-VII	ORS-4*	Nov 1, 2014	1	2
ELaNa-VIII	ORB-3	FY 2014	Nanoracks	1
ELaNa-IX	ORB-4	FY 2015	Nanoracks	3
ELaNa-X	SMAP	Dec 2014	3	3
ELaNa-XI	AFSPC-5*	FY 2015	2	2
ELaNa-XII	NROL-55*	FY 2015	2	5
ELaNa	ICESat II	FY 2017	3	
ELaNa	JPSS-1	FY 2017	3	
				48

* Consistent with the National Space Policy of 2010, NASA has agreements with the n8tional security space community to leverage our respective launch capabilities.



Announcement of Flight Opportunity

Release Date: July 31, 2014

Response Date: November 25, 2014 @ 4:30 PM EST

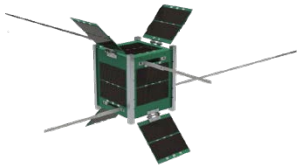
https://prod.nais.nasa.gov/cgibin/eps/synopsis.cgi?acqid=161828

Objective

NASA Human Exploration and Operations Mission Directorate is anticipates making launch opportunities for a limited number of CubeSats on launches or deployed from the ISS currently planned for 2015-2018.

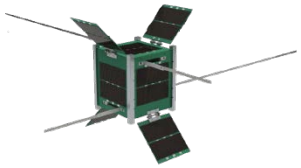
NASA will provide integration and other services as necessary to complete the launch activity.

NASA will not transfer any funds to collaborators under Agreements negotiated in response to this Announcement.



CubeSat Launch Initiative Future

August 2014	NASA announced another call for proposals
October 2014	Conduct a Virtual CubeSat Symposium
November 2014	CubeSat Launch Initiative proposals due
February 2015	NASA announce CSLI selections
2014-beyond	Increase launch capacity through ISS deployments
2014-beyond	Investigate International Collaboration with ESA and others to increase launch opportunities



Payload Eligibility

Benefit to NASA

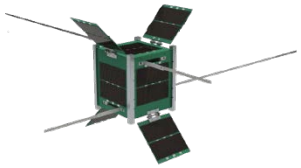
Investigation must demonstrate a benefit to NASA by addressing goals and objectives of the NASA Strategic Plan and/or the NASA Education Vision and Goals.
Cube

Merit Review

Prior to submission each CubeSat investigation must have passed an intrinsic merit review. In the review, goals and objectives of the proposed investigation must be assessed to determine scientific, educational or technical quality of the investigation.

Feasibility Review

Prior to submission each CubeSat investigation must have passed passed a feasibility review in which the technical implementation, including feasibility, resiliency, risk and probability of success, was assessed.



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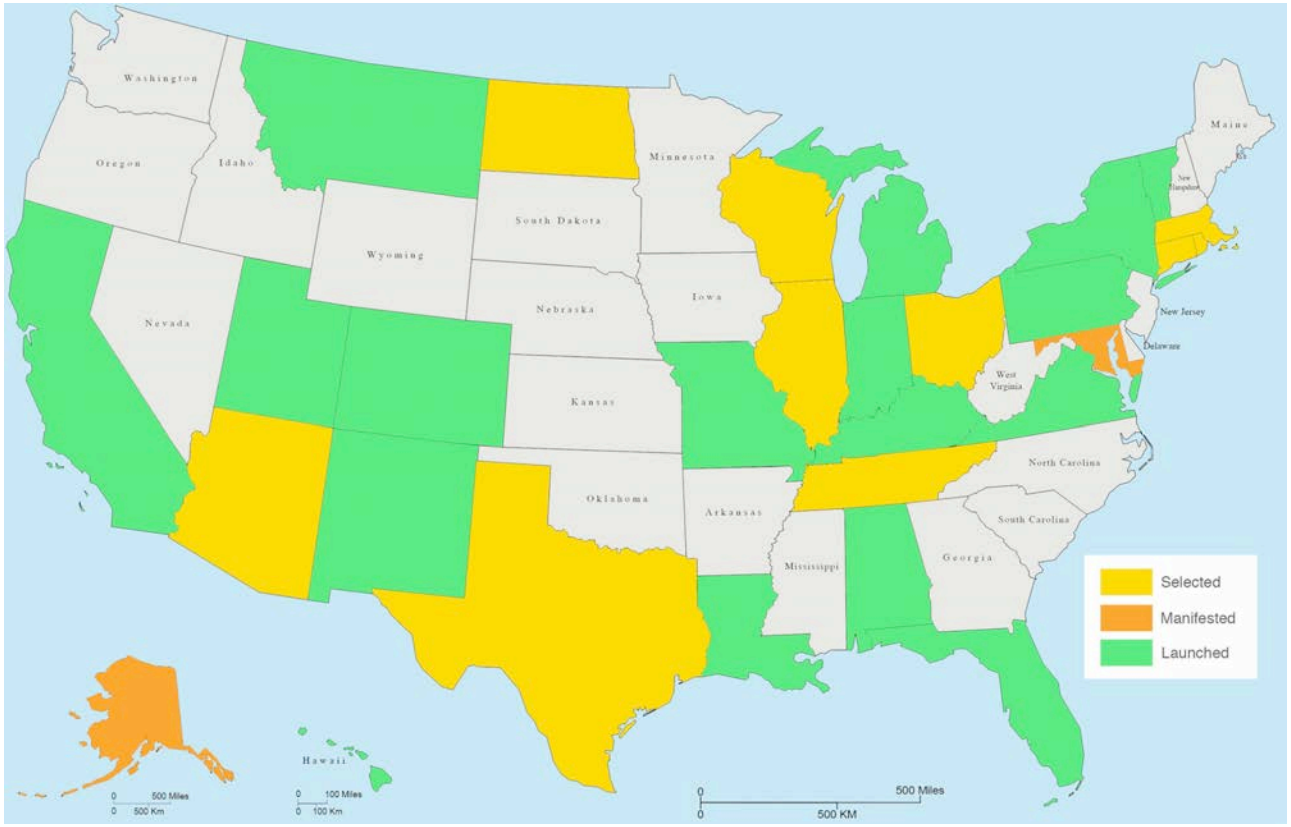
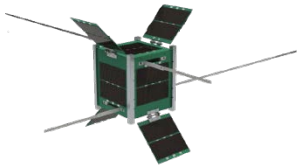
White House Maker Initiative

Goal to broaden NASA's CubeSat Launch Initiative to reach all states by targeting the 21 "rookie states" that have had no previous presence in space.





Applicant Eligibility

Eligible Applicants

- Respondent must be from a NASA center, a U.S. not-for-profit organizations, or U.S. accredited educational organizations.
- Respondent is responsible for securing funding to support the development of the CubeSat payload and for all other costs incurred by the Respondent to support its participation in the project.

Points of Contact

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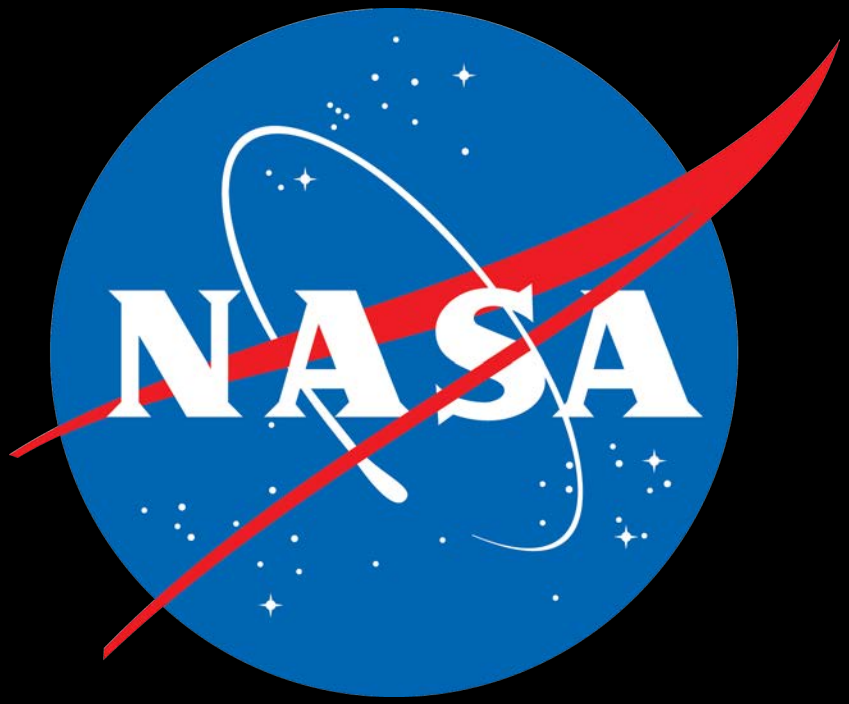
anne.sweet-1@nasa.gov

Jason Crusan
Director
Advanced Exploration Systems
202-358-0635
jason.crusan@nasa.gov

2009–2014 CubeSat

32 Flown – 16 Manifested


NASA